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REPLICA INSPECTION OF MAIN STEAM AND HOT REHEAT LINES - LIFE ASSESSMENT, LAKEVIEW UNITS 5 & 6

Report No 91-3-K

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ABSTRACT

As part of Lakeview Rehabilitation, 66 welds and 32 elbows from the high energy lines on Units 5 & 6 were inspected using surface replication techniques. Two terminal welds were found to contain Type IV creep damage and as a result, required full weld repairs. Three elbows were found to contain isolated creep cavities of a minor nature and no repair was necessary. There has yet to be a single case of Type IV damage in pipe to pipe welds at Lakeview (over 200 have been inspected). For future inspections 100 % replication of all welds may not be necessary. Replication of elbows should be continued on other units as there is still limited data on their performance.

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A1-138-472	823.413	March 8, 1991	91-3-K

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EXECUTIVE SUMMARY

REPLICA INSPECTION OF MAIN STEAM AND HOT REHEAT LINES - LIFE ASSESSMENT, LAKEVIEW UNITS 5 AND 6

I. Thompson and M.A. Clark

During Lakeview Rehabilitation, main steam and hot reheat welds and elbows were inspected by surface replication techniques on Units 5 and 6. This program was part of a larger program/1,2/ designed to assess the integrity of the high energy pipe system and provide baseline data for future inspections.

Sixty-six welds and 32 elbows were inspected by replication. Two terminal welds were found to contain Type IV Level A creep damage and therefore required full weld repairs. Three elbows were found to contain isolated cavities (Level A) and as such did not require any repair.

Including these results, over 200 high energy line welds have been inspected at LVGS following the Unit 3 and 4 'T' piece failures/4/. Only 6 confirmed incidences of Type IV creep damage have been discovered, all of which have been at terminal welds. There has been no occurrence of Type IV failures in any pipe to pipe welds. For future inspections, 100% replication of all welds may not be necessary. Only welds selected on past experience need to be replicated. Replication of elbows (with > 80,000 hours) should be continued on other units as there is still limited data on their performance.

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TABLE OF CONTENTS

INTRODUCTION 1

DISCUSSION 2

CONCLUSIONS 3

ACKNOWLEDGEMENTS 4

REFERENCES 5

APPENDIX I 12
SURFACE REPLICATION 12
CLASSIFICATION OF CREEP DAMAGE IN WELDMENTS 12

APPENDIX II 16
SUMMARY OF REPLICA RESULTS 16

LIST OF FIGURES

Figure 1. Lakeview G.S., Main Steam Lines - Unit 5. 6
Figure 2. Lakeview G.S., Hot Reheat Lines - Unit 5. 7
Figure 3. Lakeview G.S., Hot Reheat Lines - Unit 6. 8
Figure 4. Lakeview G.S., Main Steam Lines - Unit 6. 9
Figure 5. SEM micrograph of U5 WMS FW11, displaying Type IV Level A damage in SC HAZ. 10
Figure 6. SEM micrograph of U6 WMS FW 11, displaying Type IV Level A damage in SC HAZ. 10
Figure 7. SEM micrograph of U5 WHRH EL1, displaying Level A damage. 11
Figure I-1. Creep damage classification of weldments; location[7]. 14
Figure I-2. Creep damage classification of welds; severity[8]. 15

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To

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REPLICA INSPECTION OF MAIN STEAM AND HOT REHEAT LINES - LIFE ASSESSMENT, LAKEVIEW UNITS 5 & 6

I. THOMPSON & M.A. CLARK

INTRODUCTION

During Lakeview Rehabilitation, main steam and hot reheat welds and elbows were inspected by surface replication techniques on Units 5 & 6. This program was part of a larger program/1,2/ designed to assess the integrity of the high energy pipe system and provide baseline data for future inspections. Following the creep failure in the main steam line of Lakeview Unit 3 in 1989, selected welds, mostly at terminal points and boiler stop valves were inspected for similar damage on all units. The present inspection program was designed to cover all the remaining welds plus elbows in Units 5 and 6.

The replica work is intended to identify areas of components that are experiencing high temperature creep deformation which is manifested in the later stages of life by the development of detectable cavities, followed by micro-cracks and finally macro-cracks/3/. It should be noted that, lack of reported cavities does not necessarily imply that the material is totally free of creep damage but only that the process has not reached the stage of cavity development. A more detailed description of the replication technique and the creep damage classification system used for welds is given in Appendix I.

The purpose of this report is to provide a summary of the replication work performed from May-December, 1990 on these units. The report will focus on creep damage plus the results of replicas taken of other cracks discovered by other NDE techniques. Only areas containing creep damage or that require regular monitoring will be discussed in the body of this report.

RESULTS

A total of 66 welds and 32 elbows were to be inspected by using surface replication on the Units 5 & 6 high energy piping (main steam and hot reheat lines).* The replica results for all areas inspected are presented in tabular form in Appendix II. The location of these 98 areas are shown schematically in Figures 1-4. Of these 98, only 2 welds were found to contain creep damage that was significant enough to warrant a full weld repair. In addition, 3 elbows were found to contain minor creep damage that did not warrant a repair.

Replicas were taken on Main Steam (MS) Field Weld (FW) 11, terminal welds to the steam chest, on the west lines of both Units 5 and 6. These welds were inspected in 1989 and found to have some creep damage but were not repaired. At that time on FW 11 Unit 5, west, the initial replica in one location had Type IV creep damage. A subsequent replica after light grinding indicated the Type IV damage was removed. The present replica (1990) on the same location shows similar Type IV creep damage (see Fig. 5). A boat sample was removed from this weld for further evaluation before it was repaired. Examination of the boat sample confirmed the replica findings; type IV cavitation damage was found to extend below the surface to the depth of the sample, about 9 mm.

The Unit 6, FW 11, west MS weld displayed some minor Type III creep damage (Category C) in one of the locations in 1989. Replication of the same areas show the same type of damage with no apparent change. However, there is some indication of Type IV cavitation damage in one location (see Fig. 6). A boat sample was removed from this weld for further evaluation before it was repaired. Examination of the boat sample confirmed the replica findings; again damage was found to a depth of about 10 mm.

Some damage in the form of isolated cavities (Category A) has been discovered in elbow locations (EL); Unit 5 West HRH EL1 and Unit 5 East HRH EL1 and Unit 5 West MS EL 4. The damage has been confirmed by repeat replicas in only one location (U5 W HRH EL1) (see Fig 7). It appears that the regrinding procedure for repeat replicas has removed the prior indications in the other two locations.

In addition to the above, replicas were also taken on UT indications found in the weld metal (WM) of U5, FW6 west hot reheat, after cap removal. The replicas showed the defects to be weld porosity and slag inclusions.

DISCUSSION

Sixty-six welds and 32 elbows were inspected by replication. Two terminal welds were found to contain Type IV Level A creep damage and therefore required full weld repairs.

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* work on 2 elbows is still pending; U6 WMS.E4, EMS.E4

Three elbows were found to contain isolated cavities (Level A) and as such did not require any repair.

Including these results, over 200 high energy line welds have been inspected at LVGS following the Unit 3 & 4 'T' piece failures/4/. Only 6 confirmed incidences of Type IV creep damage have been discovered, all of which have been at terminal welds. There has been no occurrence of Type IV failures in any pipe to pipe welds. This raises the question of the need for 100% inspection of high energy line welds during future rehabilitation exercises. Based on this experience, it is suggested that in the future only selected welds should be replicated.

With respect to the bends, it is important to note that the presence of cavities is not definitive evidence of in-service creep damage. There is a possibility that the cavities are due to the original fabrication process since the bends are hot formed. In either case, the isolated and minor nature of the findings does not reflect a need for any repair action at this time, based on what is known about creep failure in bends. However, regardless of whether the cavities are fabrication or service-induced, they can be expected to grow under service stress/temperature conditions.

Prior to this investigation, Ontario Hydro has had little experience with creep damage in high energy bends. However, other utilities particularly in West Germany/5/, have had many failures including some that were catastrophic. These failures have occurred in 1/2Cr-1/2Mo-1/4V, P11 and P22 material in as little as 95 000 hours (for Cr/Mo/V).

For P11, the Lakeview high energy line material, it is believed that the first appearance of creep cavities occurs at 25-30% of the creep life/5/. This is about 70 000 hours for P11. Therefore, although no repair is advocated at this time, there is a definite requirement to monitor these U5,U6 locations as part of a life management program. Furthermore, as the amount of replica data on bends is limited it is also recommended that inspection of selected elbows be included in future rehabilitation or other inspection programs.

CONCLUSIONS

Of the 98 areas inspected 2 terminal welds required full weld repairs due to Type IV creep damage and 3 bends were found to contain isolated cavities (Level A).

1) Replica inspection of 100% of the high energy line welds in future rehabilitation exercises is not necessary. Only welds selected on past experience need to be replicated.

2) Since only the very early stages of creep damage were discovered in some bends, repairs are not required. Regular monitoring (every 10 000 hours) is strongly recommended, however.

3) Based on the present findings and other utilities experiences/4/, selected bends should be inspected on all Units with > 80 000 hours as part of future life management/rehabilitation programs.

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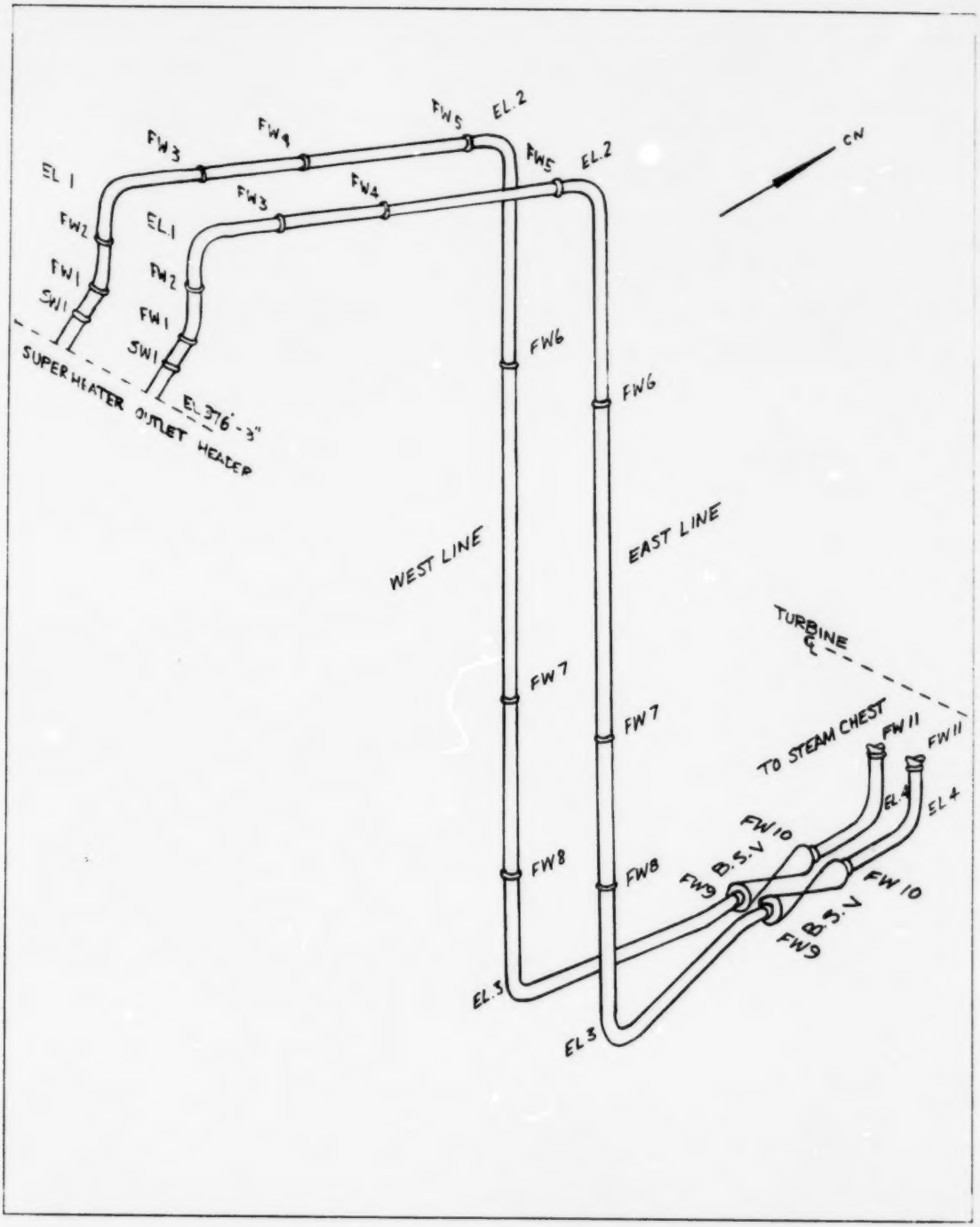

Figure 1: Lakeview G.S., Main Steam Lines - Unit 5

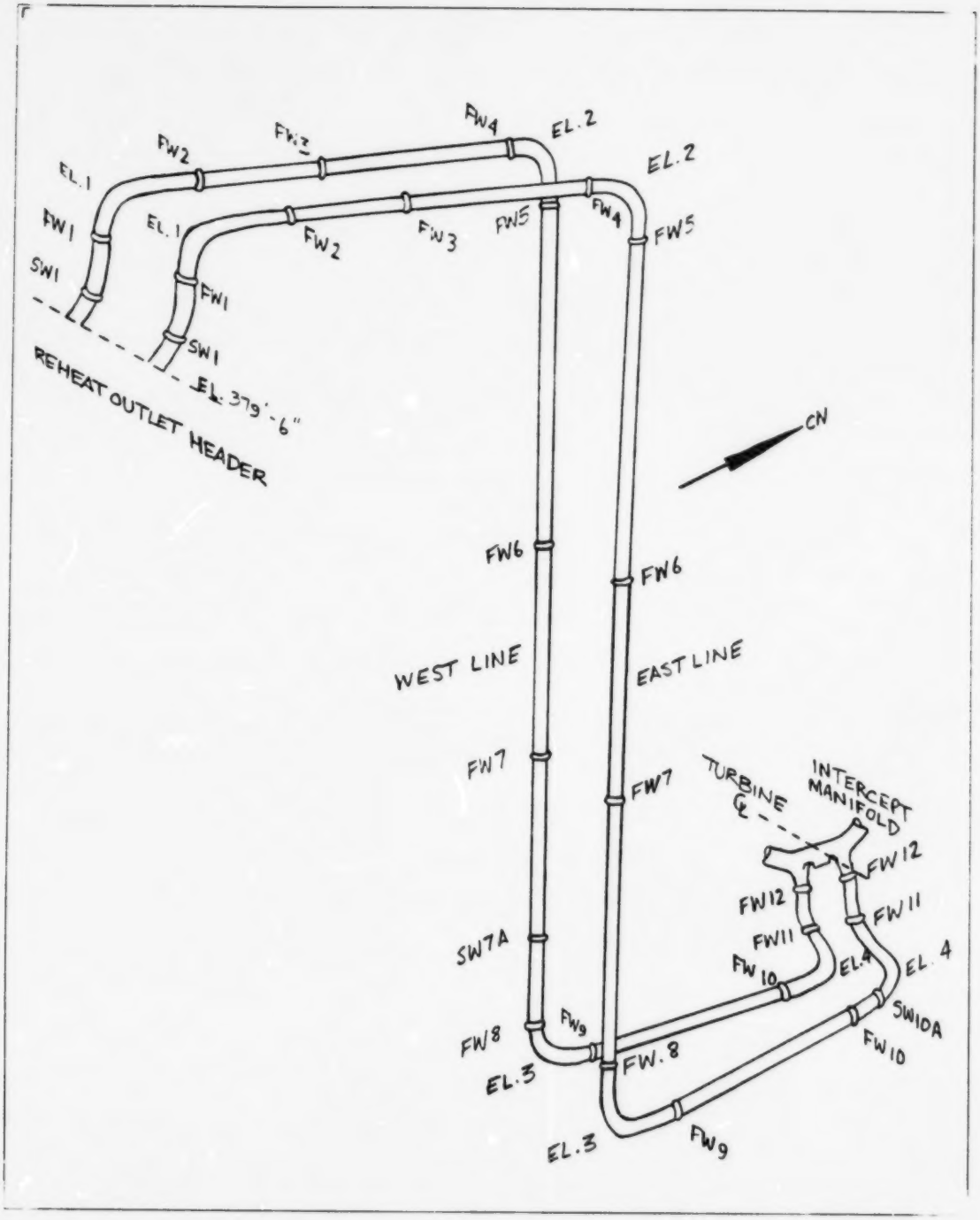

Figure 2: Lakeview G.S., Hot Reheat Lines - Unit 5.

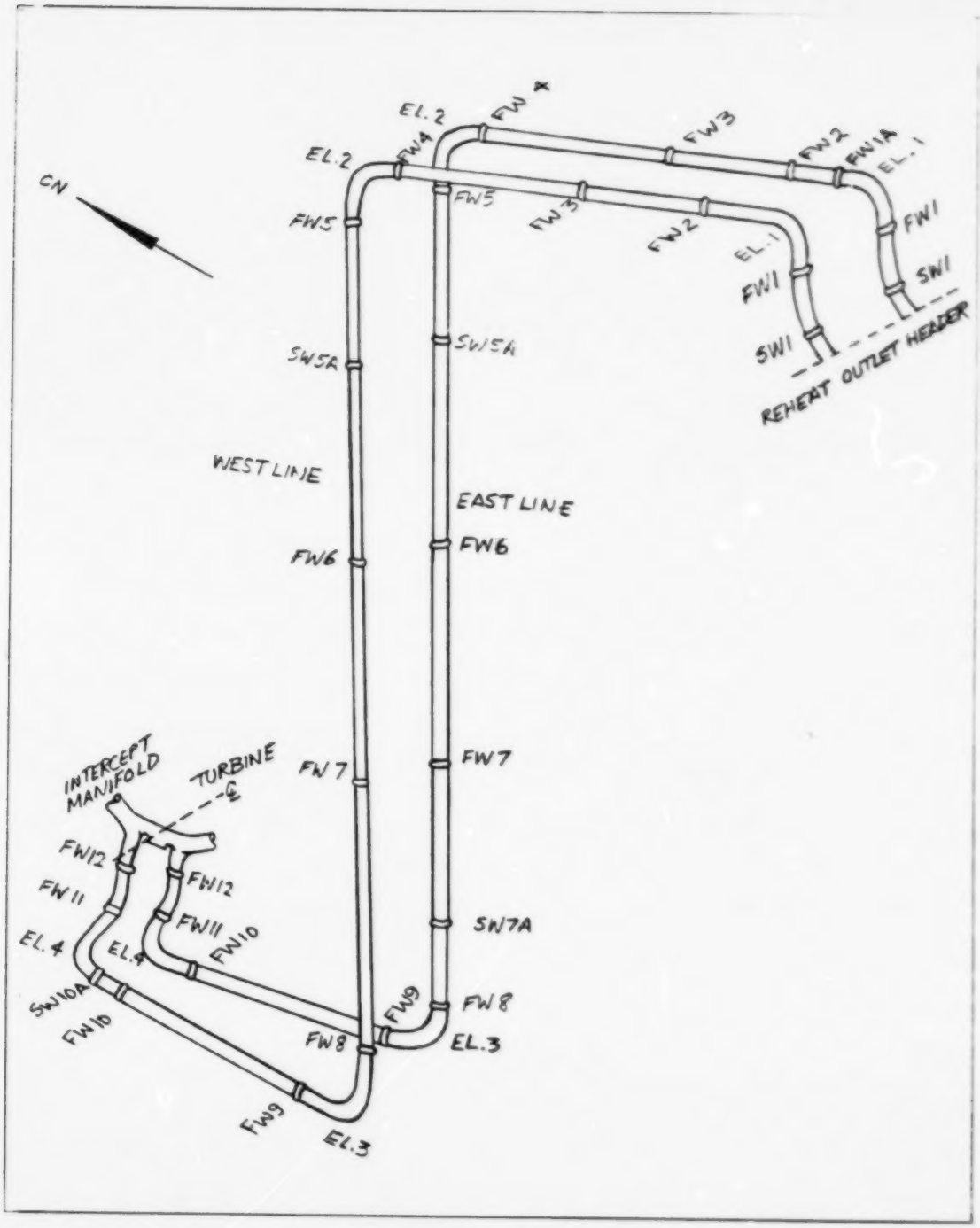

Figure 3: Lakeview G.S., Hot Reheat Lines - Unit 6.

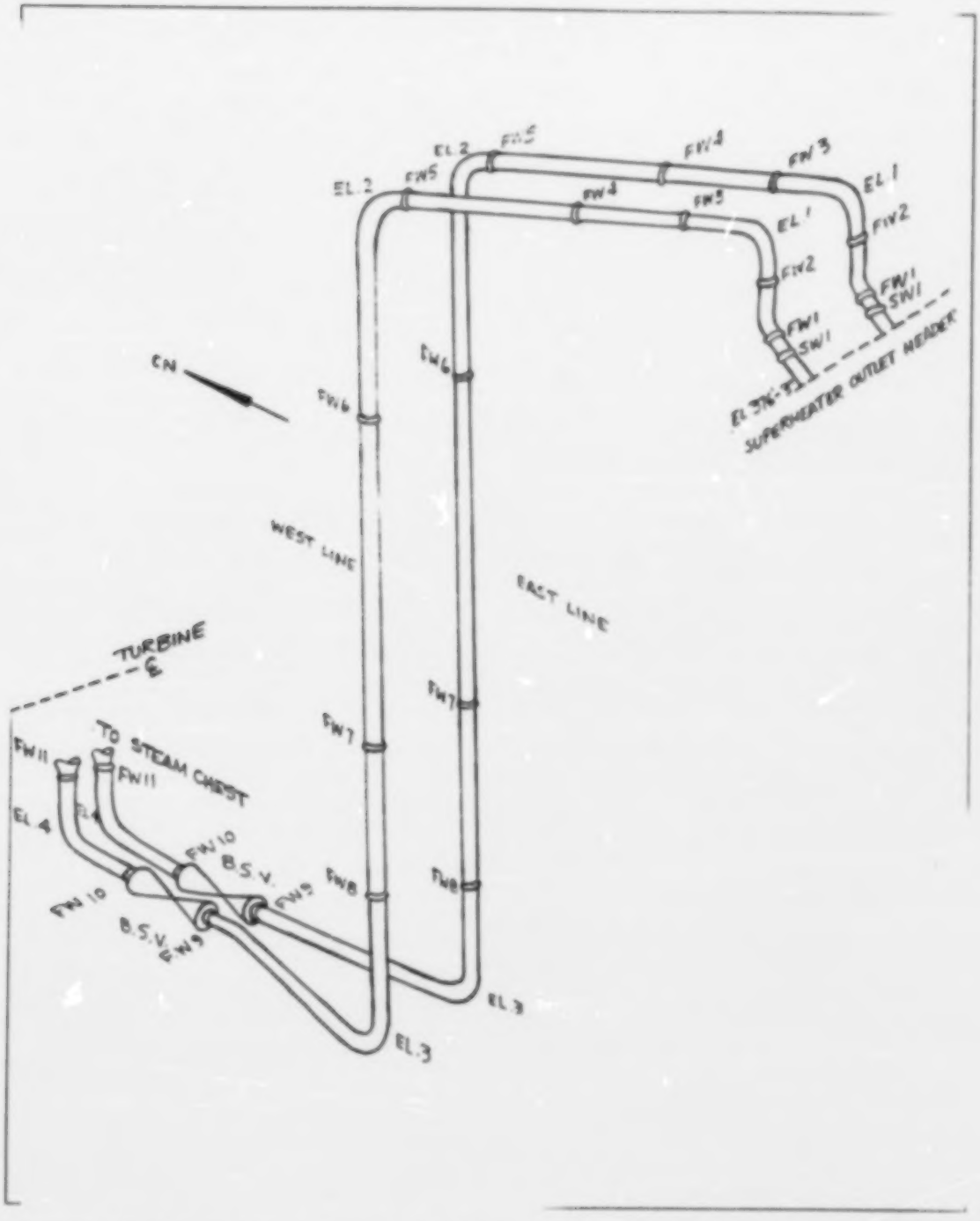

Figure 4: Lakeview G.S., Main Steam Lines - Unit 6.

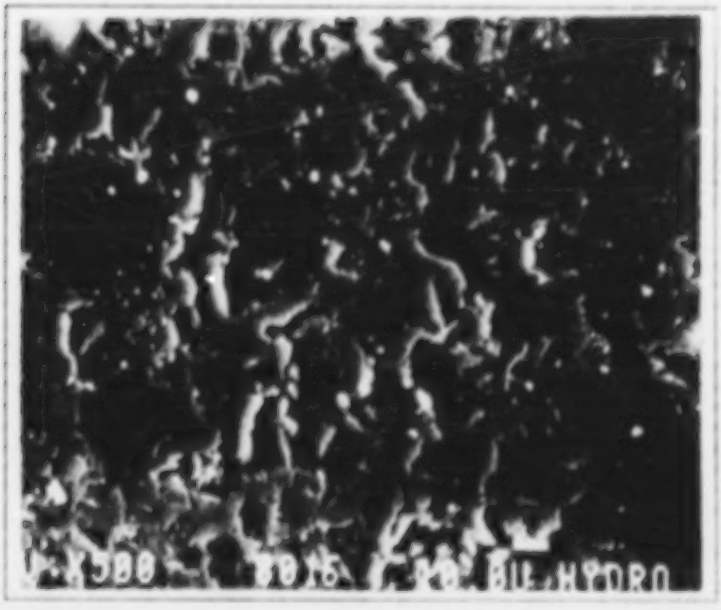

Figure 5: SEM micrograph of U5 WMS FW11, displaying Type IV Level A damage in SC HAZ, X 500

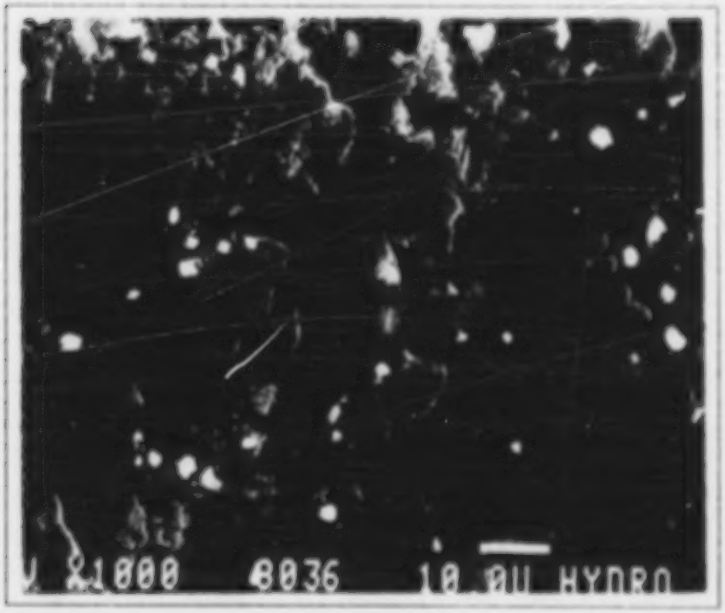

Figure 6: SEM micrograph of U6 WMS FW 11, displaying Type IV Level A damage in SC HAZ, X 1000

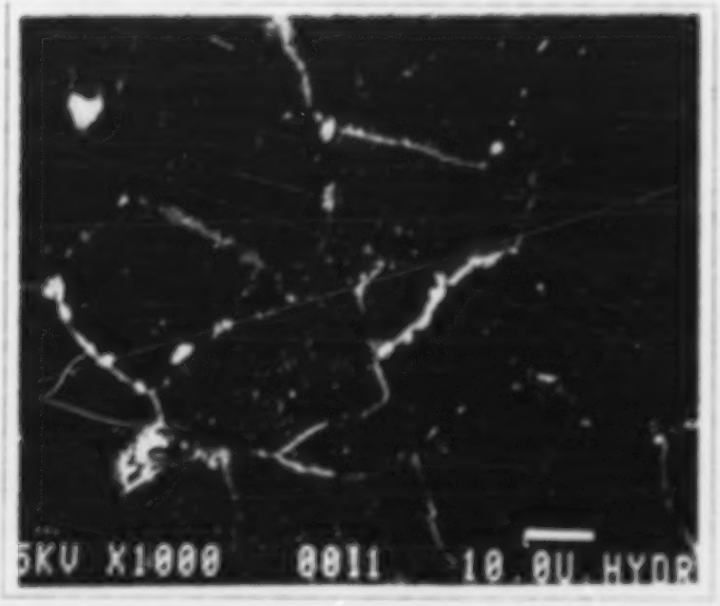

Figure 7: SEM micrograph of U5 WHRH EL1, displaying Level A damage, X 1000

APPENDIX I

REPLICATION TECHNIQUE AND CREEP DAMAGE CLASSIFICATION

SURFACE REPLICATION

Replication is a nondestructive test that involves in situ polishing and etching, in order that a "fingerprint" of the metal's structure may be recorded on a plastic (acetate) film. Replicas are examined by optical microscopy and scanning electron microscopy (SEM) at OHRD. Replicas provide information on the metal's basic microstructure and the extent of any defects such as creep cavities, microcracks and other forms of cracking. Replication is the only known nondestructive technique that can detect the early stages of creep damage.

The present method used to examine a weld involves, taking replicas at four quadrants essentially selected at random to whatever stresses are in the pipe. For a typical main steam pipe (33 cm OD), replicas can only inspect a maximum of 19 % of the total weld length and for a hot reheat pipe (51 cm OD) 12 %.

High energy bends (elbows) are also examined on four areas. Three replicas are taken approximately 12" apart on the extrados (OD), with the centre replica on the apex. A fourth replica is taken opposite the apex on the intrados (ID) of the bend.

CLASSIFICATION OF CREEP DAMAGE IN WELDMENTS

Classification of creep damage in weldments has been broken down into two categories. The first is based on the location of damage in the weldment microstructure and the second is based on the severity of the damage. The location of damage is based on a German system/7/ which classifies the damage as Type I,II,III, & IV and is shown in Figure I-1. Type I is failure occurring in the weld metal; Type II initiates in the weld metal and runs into the HAZ; Type III is in the coarse grained part of the HAZ adjacent to the fusion line; Type IV is in the region between the fine grain and partially transformed region of the HAZ/8/. The severity of damage is assigned either Level A,B,C or D and is shown in Figure I-2/6/. Level A represents isolated cavities, Level B represents oriented cavities, Level C represents linked cavities (microcracks) and Level D represents macrocracks.

Types I & II creep failure are relatively rare and have been mostly confined to longitudinal seam welds fabricated by submerged arc welds/8/. Within Ontario Hydro, longitudinal seam welds are not present in high energy pipe work and therefore this form of creep damage is of little concern.

Type III creep damage will generally nucleate at the surface of the weldment and progress through the various levels at a relatively slow rate (about 2 years per level). Therefore weldments containing this type of damage can be left in service until the latter stages with little concern of catastrophic failure.

Type IV creep damage begins as profuse but very fine cavitation that can rapidly develop into a major crack, perhaps within one year. Furthermore there is evidence to suggest that Type IV can be nucleated subsurface/4/. Thus Type IV damage detected by surface replication may be at a much more advanced stage below the surface of the pipe. For these reasons Type IV damage is considered to be unmanageable and the only solution is a full weld repair.

The Level A,B,C & D damage severity system/6/ which was originally developed for Type III, is the most common method for describing the degree of creep damage progression. Through the course of this and other studies, this method has been found deficient in accurately describing the early stages of Type IV Level A creep damage in terms of cavity density and total area covered. This has led to the creation of additional qualitative terminology in order to better describe the damage. These terms are a temporary solution until a more advanced classification system is developed.

Dense - implies that 1 or more creep cavities were observed per grain plus cavitation was found to occur throughout the entire length of the replica.

Isolated - implies that cavitation was found in less than 50 % of the replica (approx.).

Extremely Isolated - implies that cavitation was found in less than 25 % of the replica. Usually low cavity density is observed as well (ie less than 1 cavity per 5 grains).

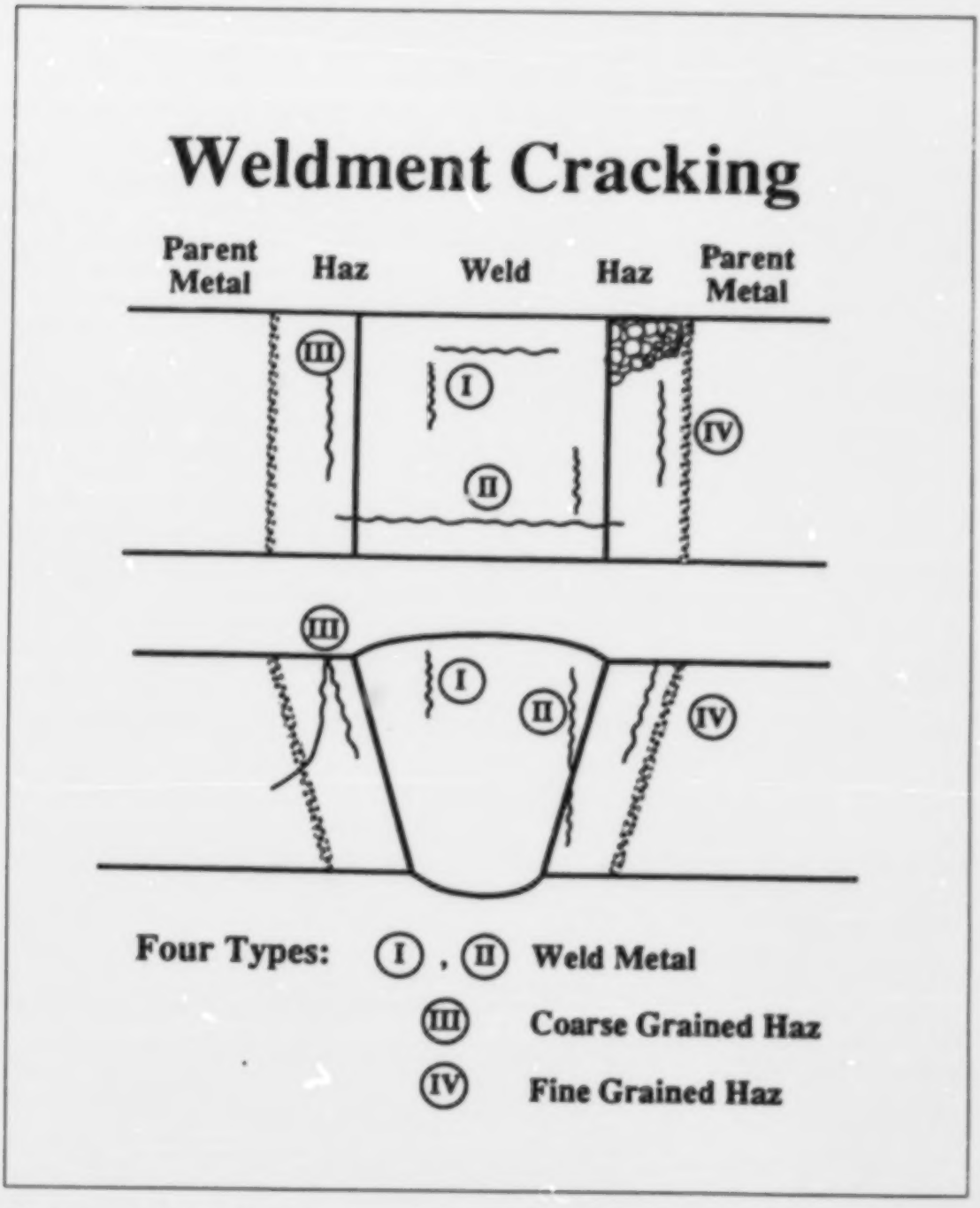

Figure I-1: Creep damage classification of weldments; location/7/.

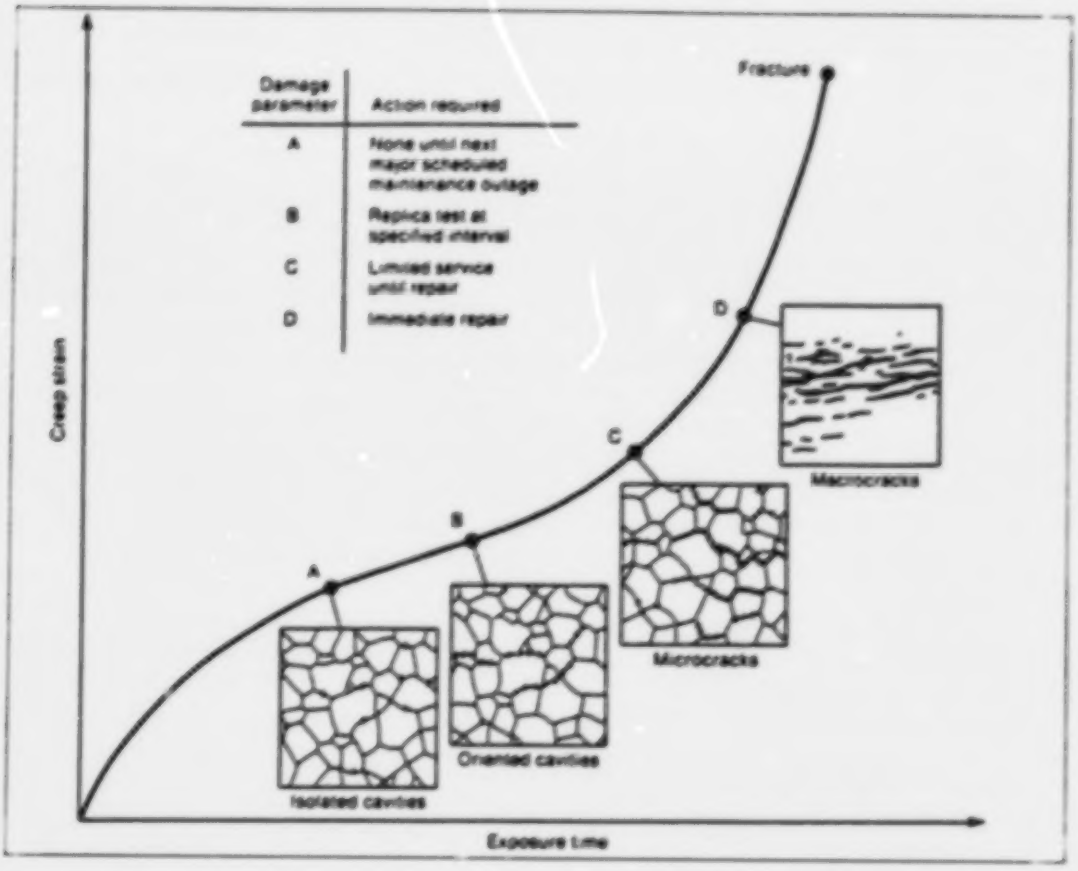

Figure I-2: Creep damage classification of welds; severity/6/.

APPENDIX II

SUMMARY OF REPLICA RESULTS

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Main Steam, Line 501	FW 2, 2nd weld from superheater outlet header.	- surface prep'd and MPI'd no indications - 4 areas replicated - TOP loc'n has arc strike in top HAZ, EAST loc'n has "double" top HAZ, no creep damage found. - released back to inspection program 02/08
Unit 5, East Main Steam, Line 501	FW 3, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd - 7 mm transverse crack in WM. - 5 areas replicated, 5 are okay - no creep damage in any replicas. - cracks in weld metal will be ground out. - released back to inspection program 26/06
Unit 5, East Main Steam, Line 501	FW 4, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 3 areas replicated, 2 are okay Top loc. has 1 mm crack in WM though no creep damage was found. - released back to inspection program 19/06

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Main Steam, Line 501	FW 5, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd - 2.5 mm transverse crack in weld metal - 5 replicas taken - no creep damage found, though WM has high ferrite content in all areas including were crack was found. - released back to inspection program 09/07
Unit 5, East Main Steam, Line 501	FW 6, vertical section at 370' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 20/07
Unit 5, East Main Steam, Line 501	FW 7, vertical section at 325' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 16/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Main Steam, Line 501	EL 1, first elbow to horizontal section above coal gallery, 394' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found, although inside loc'n (D) and lower outside loc'n (C) had a high carbide distribution at GBs. - release back to inspection program 13/08
Unit 5, East Main Steam, Line 501	EL 2, elbow connecting horizontal and vertical sections, 394' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 09/08
Unit 5, East Main Steam, Line 501	EL 3, elbow at bottom of vertical section, 282' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 13/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Main Steam, Line 501	EL 4, elbow before steam chest, 272' approximately	- surface prep'd and MPI'd no indications - 2 areas replicated (poor access) - both areas have shown isolated cavities after SEM examination. Repeat replica on extrados shows no cavitation after SEM. - released to inspection 02/10

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Main Steam, Line 502	FW 2, 2nd weld from superheater outlet header, 380' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found, although WEST loc'n in bot. HAZ has many carbides in fine grain region. - released back to inspection program 02/08
Unit 5, West Main Steam, Line 502	FW 3, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 2 areas replicated - Top & West no indications found. - released back to inspection program 22/06
Unit 5, West Main Steam, Line 502	FW 4, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 3 areas replicated - Top, East & West Top has crack in WM, others ok. - released back to inspection program 19/06

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Main Steam, Line 502	FW 5, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 2 areas replicated - West area has small crack in W.M., though no creep damage found. Top area has no damage. - released back to inspection program 10/07
Unit 5, West Main Steam, Line 502	FW 6, vertical section, 368' approximately	- surface prep'd and MPI'd no indications - 3 areas replicated - no creep damage was found - released back to inspection program 20/07
Unit 5, West Main Steam, Line 502	FW 7, vertical section, 325' approximately	- surface prep'd and MPI'd - a 3/16" slag inclusion was found in the W.M. - 4 areas replicated - no creep damage was found. - released back to inspection program 16/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Main Steam, Line 502	EL 1, first elbow to horizontal section above coal gallery, 394' approximately	- surface prep'd and MPI'd no indications - 3 areas replicated (poor access I.D. pos'n was omitted) no creep damage was found. - released back to inspection program 09/08
Unit 5, West Main Steam, Line 502	EL 2, elbow connecting horizontal and vertical sections, 394' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. Though inside pos'n (D) was found to contain a higher amount of carbides at the GBs. - released back to inspection program 02/08
Unit 5, West Main Steam, Line 502	EL 3, elbow at bottom of vertical section, 282' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 13/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Main Steam, Line 502	EL 4, elbow before steam chest, 272' approximately	- surface prep'd and MPI'd no indications - 2 areas replicated (poor access) - both were found to contain cavities following SEM examination. Repeat replicas show no damage. - released to inspection 02/10.
Unit 5, West Main Steam, Line 502	FW 11, terminal weld to steam chest, 290' approximately	- 2 areas replicated were creep damage was discovered last year by replication. - the South replica in the steam chest HAZ revealed extensive cavitation in the fine grained region (Type IV damage). No creep damage was found in the North replica - boat sample of South area has been extracted. Initial results show: boat sample contains entire steam chest HAZ for ~ 10 mm below surface. SEM exam has confirmed cavitation in Type IV region found by replication. The depth and density of these cavities is currently being investigated.

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Hot Reheat, Line 501	FW 2, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd - transverse 4 mm crack found on top side in WM. - 5 replicas taken - no creep damage was found near crack or in any other replica - released back to inspection program 04/07
Unit 5, East Hot Reheat, Line 501	FW 3, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 replicas taken - no indications were found. - released back to inspection program 19/06
Unit 5, East Hot Reheat, Line 501	FW 4, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 replicas taken - no indications found. - released back to inspection program 09/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Hot Reheat, Line 501	FW 5, vertical section at 385' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 20/07
Unit 5, East Hot Reheat, Line 501	SW 5A, vertical section at 370' approximately	- Lakeview Rehab can not locate weld - officially the weld has been deleted from the program
Unit 5, East Hot Reheat, Line 501	FW 6, vertical section at 350' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage found. - released back to inspection program 11/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Hot Reheat, Line 501	FW 7, vertical section at 330' approximately	- surface prep'd and MPI'd - 3 mm non metallic inclusion in WM at 1:00 - 4 areas replicated - EAST & SOUTH areas have a few isolated cavities in the CG Bot. HAZ. rest of weld is okay. No action taken. - released back to inspection program 16/07
Unit 5, East Hot Reheat, Line 501	FW 9, horizontal section at 270' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - TOP/EAST loc'n has 2.5 mm crack in WM (not found by MPI), BOT/EAST & BOT/WEST have more carbides at GB's in their L/HAZ's than others. - released back to inspection program 03/08
Unit 5, East Hot Reheat, Line 501	SW 10A, shop weld south of EL 4 at 270' approx.	- Lakeview Rehab can not locate weld. - officially, the weld has been deleted from the program.

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Hot Reheat, Line 501	FW 11, 2nd weld from intercept steam manifold, at 285' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - BOT. & SOUTH loc'ns have many carbides in both HAZ's. No creep damage was found. - released back to inspection program 27/07
Unit 5, East Hot Reheat, Line 501	EL 1, first elbow to horizontal section above coal gallery 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated & 2 repeated - inside loc'n (D) was to found to have possible cavities. 1mm regrind and repeat - no creep damage. - released back to inspection program 23/07
Unit 5, East Hot Reheat, Line 501	EL 2, elbow connecting horizontal and vertical sections above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found, although inside loc'n (D) had more carbides at GB's - released back to inspection program 01/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, East Hot Reheat, Line 501	EL 3, elbow at bottom of vertical section, 271' approximately	- surface prep'd and MPI'd no indications - 3 areas replicated (poor access) - no creep damage was found. - released back to inspection program 01/08
Unit 5, East Hot Reheat, Line 501	EL 4, elbow before intercept steam manifold, 272' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 01/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Hot Reheat, Line 502	FW 2, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 replicas taken - no indications found. - released back to inspection program 20/06
Unit 5, West Hot Reheat, Line 502	FW 3, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 replicas taken - no indications found. - released back to inspection program 19/06
Unit 5, West Hot Reheat, Line 502	FW 4, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 10/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Hot Reheat, Line 502	FW 5, vertical section at 385' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found, although NORTH HAZ had large # of carbides in the FG. - released back to inspection program 20/07
Unit 5, West Hot Reheat, Line 502	FW 6, vertical section at 350' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage found. - released back to inspection program 11/07
Unit 5, West Hot Reheat, Line 502	FW 7, vertical section at 330' approximately	- surface prep'd and MPI'd - 3 2-3 mm nonmetallic inclusions + minor porosity found in WM. - 4 areas replicated no creep damage was found. - released back to inspection program 16/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Hot Reheat, Line 502	SW 7A, vertical section at 290' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. WEST loc'n has higher # of carbides in bot. HAZ. - released back to inspection program 03/08
Unit 5, West Hot Reheat, Line 502	FW 9, horizontal section at 270' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. BOT.EAST loc'n has higher # of carbides in S. HAZ. - released back to inspection program 03/08
Unit 5, West Hot Reheat, Line 502	FW 11, 2nd weld from intercept steam manifold, at 280' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 27/07

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Hot Reheat, Line 502	FW 1A, An additional weld found during insulation removal. Location is south of FW 2, approximately 6.7 m south from HRS-H2, El = 397'	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 09/08
Unit 5, West Hot Reheat, Line 502	EL 1, first elbow to horizontal section above coal gallery 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated, top-outside (A) & inside (D) were repeated. Repeat of loc'n A was found to contain cavities - released to inspection program 02/10
Unit 5, West Hot Reheat, Line 502	EL 2, elbow connecting horizontal and vertical sections above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. Loc'n C & D had a higher # of carbides at GBs. - released back to inspection program 01/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 5, West Hot Reheat, Line 502	EL 3, elbow at bottom of vertical section, 271' approximately	- surface prep'd and MPI'd no indications found. - 3 areas replicated (Loc'n C omitted due to poor access) - no creep damage was found. - released back to inspection program 01/08
Unit 5, West Hot Reheat, Line 502	EL 4, elbow before intercept steam manifold, 272' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 01/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Main Steam, Line 602	FW 2, 2nd weld from superheater outlet header.	- surface prep'd and MPI'd no indications - 4 areas replicated: South loc'n has 0.5 mm circum. crack in WM all other areas are okay. - released back to inspection program 19/10
Unit 6, East Main Steam, Line 602	FW 3, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 2 areas replicated: Top & Bot.West no creep damage was found. - released back to inspection program 22/06
Unit 6, East Main Steam, Line 602	FW 4, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 3 areas replicated - no creep damage was found. - released back to inspection program 26/90

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Main Steam, Line 602	FW 5, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 04/09
Unit 6, East Main Steam, Line 602	FW 6, vertical section at 370' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. N.W. loc'n had dense carbide distribution in BOT. HAZ. - released back to inspection program 30/08
Unit 6, East Main Steam, Line 602	FW 7, vertical section at 325' approximately	- surface prep'd and MPI'd no indications. - 4 areas replicated: no creep damage was found. Although all areas have a dense distribution of carbides. - released back to inspection program 27/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Main Steam, Line 602	EL 1, first elbow to horizontal section above coal gallery, 394' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10
Unit 6, East Main Steam, Line 602	EL 2, elbow connecting horizontal and vertical sections, 394' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10
Unit 6, East Main Steam, Line 602	EL 3, elbow at bottom of vertical section, 282' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Main Steam, Line 602	EL 4, elbow before steam chest, 272' approximately	- surface prep'd and MPI'd no indications

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Main Steam, Line 601	FW 2, 2nd weld from superheater outlet header, 380' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no damage was found. - released back to inspection program 19/10
Unit 6, West Main Steam, Line 601	FW 3, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 3 areas replicated - Top and West were SEM'd - no creep damage was found in any areas. - released back to inspection program 04/07
Unit 6, West Main Steam, Line 601	FW 4, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications - 3 areas replicated - no creep damage was found. - released back to inspection program 21/06

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Main Steam, Line 601	FW 5, horizontal section above coal gallery, 394' approx.	- surface prep'd and MPI'd no indications. - 4 areas replicated - no creep damage was found. - released back to inspection program 07/09
Unit 6, West Main Steam, Line 601	FW 6, vertical section, 368' approximately	- surface prep'd and MPI'd no indications. - 4 areas replicated: S.W. loc'n has arc strike plus porosity in TOP HAZ, other areas are okay. - released back to inspection program 30/08
Unit 6, West Main Steam, Line 601	FW 7, vertical section, 325' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 27/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Main Steam, Line 601	EL 1, first elbow to horizontal section above coal gallery, 394' approximately	- surface prep'd and MPI'd no indications - 4 area replicated: no creep damage found - released back to inspection program 05/11
Unit 6, West Main Steam, Line 601	EL 2, elbow connecting horizontal and vertical sections, 394' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10
Unit 6, West Main Steam, Line 601	EL 3, elbow at bottom of vertical section, 282' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Main Steam, Line 601	EL 4, elbow before steam chest, 272' approximately	- surface prep'd and MPI'd no indications
Unit 6, West Main Steam, Line 601	FW11, terminal weld to steam chest, at 290' approximately	- 3 areas were replicated all displayed minor amounts of creep damage following SEM & TEM examination. North - localized type III in S.C. HAZ N.W. - isolated cavities in F.G. S.C. HAZ South - many VC ppts/cavities in type III/IV region of S.C. HAZ. following TEM and BEI results, VC indications are infact cavities (Type IV level A) - Boat sample taken - A full weld repair was completed following these results.

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Hot Reheat, Line 602	FW 2, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - BOT.WEST was SEM'd no creep damage was found all other areas were okay. - released back to inspection program 06/07
Unit 6, East Hot Reheat, Line 602	FW 3, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 06/07
Unit 6, East Hot Reheat, Line 602	FW 4, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 04/09

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Hot Reheat, Line 602	FW 5, vertical section at 385' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 07/09
Unit 6, East Hot Reheat, Line 602	SW 5A, vertical section at 370' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 04/09
Unit 6, East Hot Reheat, Line 602	FW 6, vertical section at 350' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 27/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Hot Reheat, Line 602	FW 7, vertical section at 330' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damaged was found. - released back to inspection program 22/08
Unit 5, East Hot Reheat, Line 602	SW 7A, vertical section at 290' approx.	- unable to locate weld. - action: weld has been deleted from the program.
Unit 6, East Hot Reheat, Line 602	FW 9, horizontal section, first weld from lower elbow # 3 at 271'	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. BOT.WEST loc'n has 1mm crack in WM (not creep related). - released back to inspection program 21/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Hot Reheat, Line 602	FW 8, vertical section above lower elbow, at 280' approx.	- surface prep'd and MPI'd no indications. - 4 areas replicated: no creep damage was found. - released back to inspection program 04/09
Unit 6, East Hot Reheat, Line 602	EL 2, elbow connecting horizontal and vertical sections above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, East Hot Reheat, Line 602	EL 3, elbow at bottom of vertical section, 271' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 19/10
Unit 6, East Hot Reheat, Line 602	EL 4, elbow before intercept steam manifold, 272' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: 3 OD loc'ns have slight possibility of very isolated cavities. SEM req'd to confirm. - released back to inspection program 07/09
Unit 6, East Hot Reheat, Line 602	EL 1, elbow connecting pipe from reheater outlet header to horizontal section above coal gallery, at 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated:Loc'n C & D have possible isolated cavities/carbides. SEM is recommended at latter date. - released back to inspection program 19/10

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6 East Hot Reheat, Line 602	FW 11, vertical section to steam chest, at 280' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 16/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Hot Reheat, Line 601	FW 2, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 04/07
Unit 6, West Hot Reheat, Line 601	FW 3, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated - no creep damage was found. - released back to inspection program 26/90
Unit 6, West Hot Reheat, Line 601	FW 4, horizontal section above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 07/09

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Hot Reheat, Line 601	FW 5, vertical section at 385' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: SOUTH loc'n has arc strike + carbides in FG Top HAZ Bot. HAZ has isolated III A, WEST loc'n contains isolated III A in BOT HAZ also. - released back to inspection program 07/09
Unit 6, West Hot Reheat, Line 601	SW 5A, vertical section at 370' approximately	- unable to locate weld. - action: weld has been deleted from the inspection program.
Unit 6, West Hot Reheat, Line 601	FW 6, vertical section at 350' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 22/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Hot Reheat, Line 601	FW 7, vertical section at 330' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 22/08
Unit 6, West Hot Reheat, Line 601	FW 9, horizontal section at 270' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. BOT.EAST loc'n has 1 mm crack in WM - released back to inspection program 21/08
Unit 6, West Hot Reheat, Line 601	SW 10A, shop weld south of EL 4 at 270' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 21/08

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Hot Reheat, Line 601	FW 11, 2nd weld from intercept steam manifold, at 285' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated no creep damage was found. - released back to inspection program 16/08
Unit 6, West Hot Reheat, Line 601	EL 1, first elbow to horizontal section above coal gallery 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated, no creep damage - released to inspection program 11/11
Unit 6, West Hot Reheat, Line 601	EL 2, elbow connecting horizontal and vertical sections above coal gallery, 398' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10

LAKEVIEW UNITS 5 & 6 MAIN STEAM AND HOT REHEAT LINE REPLICA INSPECTIONS

LINE	LOCATION	STATUS
Unit 6, West Hot Reheat, Line 601	EL 3, elbow at bottom of vertical section, 271' approximately	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 19/10
Unit 6, West Hot Reheat, Line 601	EL 4, elbow before intercept steam manifold, 272' approx.	- surface prep'd and MPI'd no indications - 4 areas replicated: no creep damage was found. - released back to inspection program 07/09